https://doi.org/10.33472/AFJBS.6.6.2024.8145-8158

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Effect of Caffeine as a Substitute Supplement in Elite Cyclists with High-Risk Attitude for Performance Enhancement and Doping

Deepakram Thulasiraman[1*], Ramesh C[2], Arvind Shanmugam[3], Harish Narayanan[4], Vaishali Ravishankar[5], Siva Prasanth S[6], Sourav SU[7], Muthu Kumar S[8], Vignesh Kumar R[9]

[1*,2,3,4,5,6,7,9]Department of Sports Medicine, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam- 603103, Tamil Nadu, India

Corresponding Author: [1*]Deepakram Thulasiraman
Email: 1*Deepakram707@gmail.com
[1*]Department of Sports Medicine, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam- 603103, Tamil Nadu, India

Article Info

Volume 6, Issue 6, August 2024

Received: 11 June 2024

Accepted: 14 July 2024

Published: 09 August 2024

doi: 10.33472/AFJBS.6.6.2024.8145-8158

ABSTRACT:

Introduction: Doping in sports is becoming more prevalent and diverse. Elite athletes seek a substitute supplement but end up with potential health risks. This study deals with caffeine supplementation as an alternative and a safe supplement in elite cyclists with an increased performance enhancement attitude scale

Methodology: The Performance-Enhancement Attitude Scale (PEAS) questionnaire was used to select 20 elite cyclists. In this study, caffeine gel and placebo gel were used. The same subjects were used in two trials, one using caffeine gel and the other with placebo gel. Following supplementation, participants cycled ten kilometers and ran five kilometers. Analysis was done on the time trial performance, speed, average and maximum heart rates, and rating of perceived exertion.

Results: The study population's time trial performance during a 10-kilometer cycling ride with placebo and caffeine gel was (21.83 ± 1.8 vs 21.03 ± 2.26 min: p <0.001). Similarly, it was (37.34 ± 4.19 vs 36.48 ± 4.07 min: p < 0.001) in the 5-kilometer treadmill. Following supplementation with caffeine gel and placebo, the rating of perceived exertion (RPE) was (15.4 ± 1.39 vs 13 ± 2.43: P < 0.001) for treadmill running and (14.4 ± 2.26 vs 12 ± 3.15: P < 0.001) for cycling ten kilometers.

Conclusion: This study clearly addresses caffeine as a safe supplement in moderate doses that serves as a significant alternative supplement for elite cyclists with higher performance enhancement attitude scales. This study addressed improvements in perceived exertion ratings and time trials following caffeine ingestion.

Keywords: Doping, Elite Cyclists, Caffeine gel, Performance enhancing agents, Doping prevention.

© 2024 Deepakram Thulasiraman, This is an open access article under the CC BY license (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you giveappropriate credit to the original author(s) and the source, provide a link to the Creative Creative Commons license, and indicate if changes were made

1. Introduction

Doping in sports is becoming more prevalent and diverse. New doping methods are constantly being developed around the world and major sports ethics organizations aim for more effective detection methods. Data gathered estimated that 14–39 % of current adult elite athletes intentionally used doping(1). The sports disciplines indicated most often in which doping is used include cycling, weightlifting, bodybuilding, athletics, and cross-country skiing(2). Cycling sports require major endurance and motivation to sustain longer and perform better on

a time trial basis. High performance in endurance sports, such as cycling, is dependent on a variety of factors, including training load, recovery strategies, psychological factors, and optimal nutrition. Despite training, elite athletes lag in their time trial performance and are unable to complete the task in the allotted time due to perceived exertion. As a result, to improve their time trial performance, athletes use ergogenic aids. Elite cyclists must have a higher perceived exertion rating and mental ability to compete and train effectively. To overcome the challenges ahead, cyclists, particularly elite cyclists, are more prone to doping and face serious health risks. The commonly used doping substances include use of amphetamines, Human growth hormone, Probenecid, testosterone and Erythropoietin. Prohibition of tramadol was adopted only by the Union Cycliste Internationale (Union Cyclist Internationale, 2019) in response to the high use of this opioid mainly in road cycling(3). A popular ergogenic aid, Caffeine (1,3,7-trimethylxanthine) is known to be used by athletes of every level. Caffeine supplements have been a promising factor in acutely enhancing performance in various aspects over time(4). Caffeine has consistently been shown to improve exercise performance when consumed in doses of 3-6 mg/kg body mass(5). Caffeine has consistently been demonstrated to improve elite cyclists' performance. In a developing nation like India, elite cyclists perpetually encompass themselves in various performance-enhancing agents in order to improve their performance in terms of engaging during particular competition and training. Indian elite athletes report low awareness about anti-doping rules and prohibited substances with low proportion of athletes reporting doping and being tested for doping(6). The most prevalent cause of doping is negligence in the evaluation of active ingredients in supplements marketed in the sports supplement industry, athlete's lack of awareness about doping practices, readily available substances, and an array of other parameters. During endurance activities, elite athletes seek a substitute supplement for increased energy and motivation. In that case, many elite athletes are unintentionally exposed to potentially harmful supplements and a less fortunate healthier way of life. And these athletes have subjected themselves to several serious, unnoticed health risks. Preventing unintentional doping seems especially important in view of the high number of athletes using dietary supplements, as some studies have shown that these supplements can be contaminated and can contain prohibited substances such as anabolic steroids or stimulants(7). Many of the currently offered prevention programs do not seem to provide athletes with all the tools they need to deal with difficult situations during their athletic career (e.g., peer pressure, setbacks in performance(8). The purpose of this study was to assess doping-prone elite cyclists and recommend alternative and as well as a safe supplement. Elite cyclists engage in doping to enhance performance, better time trial performance, rating of perceived exertion, improved mental ability, and a positive outcome during competition and training. Rating of perceived exertion and time trial performance seems to be the main factors associated with performance during the cycling competition. For elite match-sprint cyclists, qualifying time-trial performance largely determines success in the overall tournament(9). Ingesting coffee providing 3 mg·kg-1 of caffeine improved 5 km cycling time trial performance in men and women, and by a similar magnitude(10). The caffeine-induced increase in time trial intensity likely explains all of the associated increases in heart rate and oxygen uptake, and part of the increase in blood lactate and blood glucose(11). The Rating of perceived exertion (RPE) is considered valid and reliable and has become a widely used method of quantifying internal Training load(12). The attenuation of pain during exercise as a result of caffeine supplementation may also result in a decrease in the RPE during exercise(13). Performance improvement was accompanied by a decrease in pain perception as well as a decrease in RPE under caffeine conditions(14). Studies consistently show that caffeine consumption improves performance. Despite being susceptible to doping substances and harmful agents, elite athletes can use caffeine as a safer supplement in moderate quantities. A meta-analysis found an ergogenic effect of caffeine consumed in very

small doses (0.9–2 mg/kg) on muscular strength, muscular endurance, and mean velocity(15). Evidence supported that consumption of ≤400 mg/day in adults is not associated with overt, adverse effects(16). But excessive caffeine consumption can cause negative health consequences such as psychomotor agitation, insomnia, headache, gastrointestinal complaints. Moderate consumption is always a better ergogenic aid for elite cyclists. Cycling was seen as a major engaging activity during the COVID-19 pandemic and an increase in involvement in cycling post pandemic. Cycling was seen as a reliable and resilient option in pandemic times as it enabled social distancing and a low risk of contagiousness(17). In a developing country like India, cycling appears to be a growing trend among young adults. This scenario is especially evident in other Asian countries(18). Elite cycling competitions take place within a complex social and organizational setting, where economic, socio-cultural, and historical forces shape behavior and decisions made by governing bodies, race organizers, cycling teams, and the cyclists themselves(19). Doping has become a common practice in India, where elite athletes compete in a variety of sports. Doping is a serious issue for India as the techniques of doping are ever-evolving and athletes don't fear of getting caught(20). Doping prevention measures should be scientifically monitored and evaluated in longitudinal or experimental designs. This approach implies the need for long-term research funding opportunities that also include consideration of follow-ups(21). In terms of tailored doping prevention measures, developers of anti-doping interventions should consider a modular system that offers participants opportunities for differentiation within an overarching theme. This differentiation should increase interest and enable more efficient learning(22).This study aims to develop doping prevention strategies as well as alternative approaches using safer supplements such as caffeine to improve performance. It also pays way for positive spirit among elite athletes to improve sporting activity and sportsmanship.

2. Material and methods

Participants

Inclusion criteria: Elite cyclists of age between 20 to 40 years, both men and women without any recent injury are included in this study. They were chosen from the Chennai cycling club. The cycling club is made up of hundreds of cyclists who train for a year-long competition. Training at semi-professional, Professional, and as well as Elite level. In this study, Elite Cyclists who competed in multiple 50km, 100km, and 150km categories and those who competed in more than ten professional cycling competitions in a single year were included in this study. Participants who regularly consume supplements such as Creatine, Whey protein, Glutamine, and Beta-alanine were recruited for the study. Cyclists who have not used caffeine supplements during the training period, competition were alone chosen for this study. 20 elite cyclists were selected based on Performance-Enhancement Attitude Scale (PEAS) questionnaire. PEAS is a self-reporting questionnaire instrument, measuring the consciously thought and deliberately expressed (explicit) attitude toward doping. The scale scores are interpreted as the higher the score, the more positive or lenient the attitude toward doping.

Exclusion criteria: People with concurrent medical conditions such as diabetes mellitus, hypertension, and thyroid issues were not allowed to participate in this study. Exclusions from the study included those with neuromuscular, cardiovascular, respiratory, and gastrointestinal conditions. The study did not include cyclists who regularly consumed caffeine or used supplements. Cyclists who had muscle strain, fractures, or ligament sprains were not allowed to compete.

Procedure

A longitudinal, counterbalanced study design was used in this investigation. Both placebo gel and caffeinated gel were used in this research. The caffeine gel utilized in this study was MAURTEN'S GEL 100 CAF 100 and the Placebo gel used in the study was MAURTEN'S GEL 100 and both contained the following ingredients: Glucose, Fructose, and gelling agents like calcium carbonate, Gluconic acid, and sodium alginate. Each sachet weighs 40 g and contains 100 calories along with nutrition information (carbohydrates 25 g, protein 0 g, and fat 0 g) without any added flavors, colorants, or preservatives. Both caffeine gel and placebo gel contained same formulations except The GEL 100 CAF 100 which contains 100 mg of caffeine. The only difference between the gels given to the subjects was that the placebo gel (MAURTEN'S GEL 100) contained no caffeine whereas the (MAURTEN'S GEL 100 CAF 100) contained caffeine. Both the supplement was tested and certified by Informed Sport which was accredited by LGC (the globally recognised testing laboratory behind Informed Sport) which is a world-renowned sports doping control and research supplement testing lab.

A week before the trial, the participants acquired instructions. Before the trail, participants were asked to abstain from caffeine consumption for one week. The participants received a detailed list of the most popular foods and beverages that contain caffeine to make the process of limiting caffeine easier. The participants arrived at the sports medicine lab in a complete fasting state, having been instructed not to consume any food or beverages after waking up, except plain water. The participants were asked not to engage in any strenuous physical activity the day before each testing session, and to continue with their usual dietary and sleeping routines. Before the trial, Prior consent was obtained from the participants. On two different days, the trial was held. Day 1 with placebo gel and Day 2 with caffeine gel, respectively. The supplement was taken exactly one hour before the trial on both days. The trial was conducted from 6 am to 10 am. Totally 20 participants were allocated on a slot basis prior day of the trail. The study was conducted in Chennai Province, Tamil Nadu, India, at the Sports Medicine Lab, Department of Sports Medicine, Chettinad Hospital & Research Institute. The participants were given 10 minutes to warm up after consuming the caffeine-containing or placebo gel before the testing session began. On both days participants did cycling on a stationary cycle ergometer and ran on a treadmill with the room temperature at 26°C and humidity ranged between 40% to 50%.

Schiller ERG 910 plus cycle ergometer was used in this study as the stationary cycle ergometer. It has a Load range of 20 – 500 watts with a patient weight of up to 160 kg. It also has a Blood pressure measurement with a QRS trigger for continuous monitoring of Blood pressure, Heart rate, Respiratory rate, and other vital parameters. Life fitness SCIFIT® AC5000 TREADMILL was used for running With a speed of 1 mph/5 kph, adjustable in 1 increments with a Speed range of 0.1 - 12 mph. Same protocol was followed on both days. One hour after the ingestion of the supplement, On both days after the warm-up, Participants did cycling of 10 kilometers and the resistance was not set constant and it was adjusted by the cyclists. Followed by cycling the participants did running in the treadmill for 5 kilometers in a treadmill at their own pace with the adjustable speed. The vital parameters of the participants were monitored continuously. On both days, participants' heart rate measurements during the time trials, as well as their speed, average, and maximum heart rates, are recorded and observed.

Statistical analysis

Cycling and treadmill had been taken into consideration as the number one final results variables. Descriptive evaluation became completed through frequency and share for express variables and implies widespread deviation for non-stop variables. Data additionally represented the use of suitable diagrams like pie diagram , and bar charts.The implied distinction among pre- and post-take a look at of variables became assessed through the use of

paired to take a look at. P value < 0.05 was taken into consideration as statistically significant. IBM SPSS model 22 was used for statistical evaluation.

3. Results

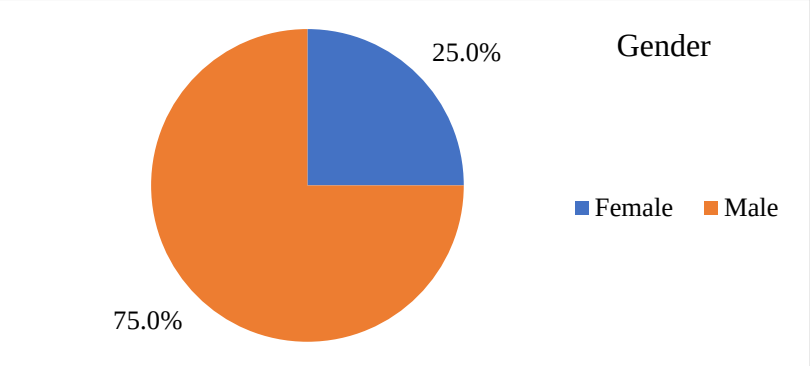


Figure 1: Gender distribution

Table 1: Demographic variables of study population between group(N=20)

Parameter	Cycling	Treadmill
Weight (kg)	**67.45 ± 6.62**	
Height(cm)	**173.65 ± 6.33**	
BMI	**22.29 ± 1.27**	

In this study, 15 males and 5 Females were recruited (Figure 1). Among the study population, the mean weight was 67.45 ± 6.62, the mean height was 173.65 ± 6.33, the mean BMI was 22.29 ± 1.27 (Table 1).

Table 2: Descriptive analysis of Placebo gel (Day 1) and Caffeine gel (Day 2): Cycling of (10kms) and treadmill (5kms) between group(N=20)

Parameter	**Group (Mean± SD)**	
	Cycling (10km) (N=20)	**Treadmill (5km) (N=20)**
Time trial with Placebo gel (Day 1) (mins)	21.83 ± 1.8	37.34 ± 4.19
Time trial with Caffeine gel (Day 2) (mins)	21.03 ± 2.26	36.48 ± 4.07

Among the study population, in cycling group the mean timing of Placebo gel (10kms) Day 1 (mins) was 21.83 ± 1.8 and it was 37.34 ± 4.19 in treadmill group (Figure 2). And in cycling group the mean Timing after ingestion of caffeine gel (10kms) Day 2 (mins) was 21.03 ± 2.26 and it was 36.48 ± 4.07 in treadmill group (Table 2).

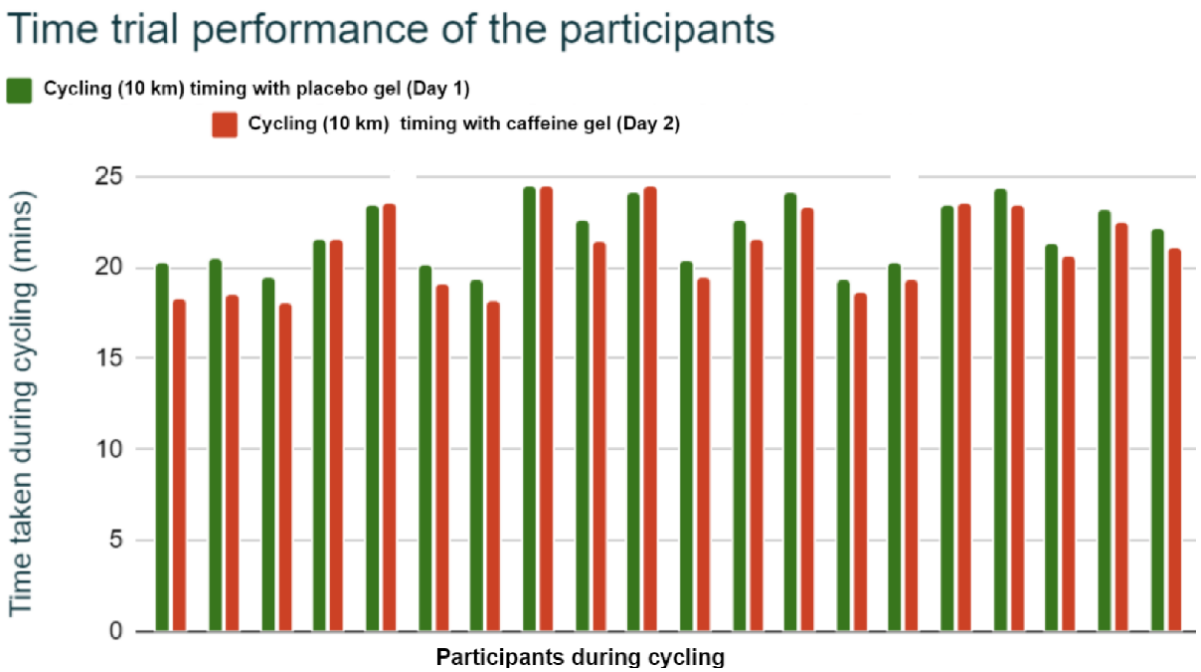


Figure 2: Time trial performance in cycling with placebo gel (green) and caffeine gel (red)

Table 3: Descriptive analysis of Rating of perceived exertion (RPE) values (6 to 20) of Placebo and caffeine gel between group(N=20)

Parameter	Group (Mean± SD)	
	Cycling (N=20)	Treadmill (N=20)
RPE values with Placebo gel Day 1 (6 to 20)	14.4 ± 2.26	15.4 ± 1.39
RPE values with caffeine gel Day 2 (6 to 20)	12 ± 3.15	13 ± 2.43

Among the study population, in cycling group the mean Rating of perceived exertion (RPE) values with placebo gel (Day 1) was 14.4 ± 2.26 and it was 15.4 ± 1.39 in treadmill group (Table 3). And in cycling group the mean RPE values with caffeine gel (Day 2) was 12 ± 3.15 and it was 13 ± 2.43 in treadmill group (Figure 3).

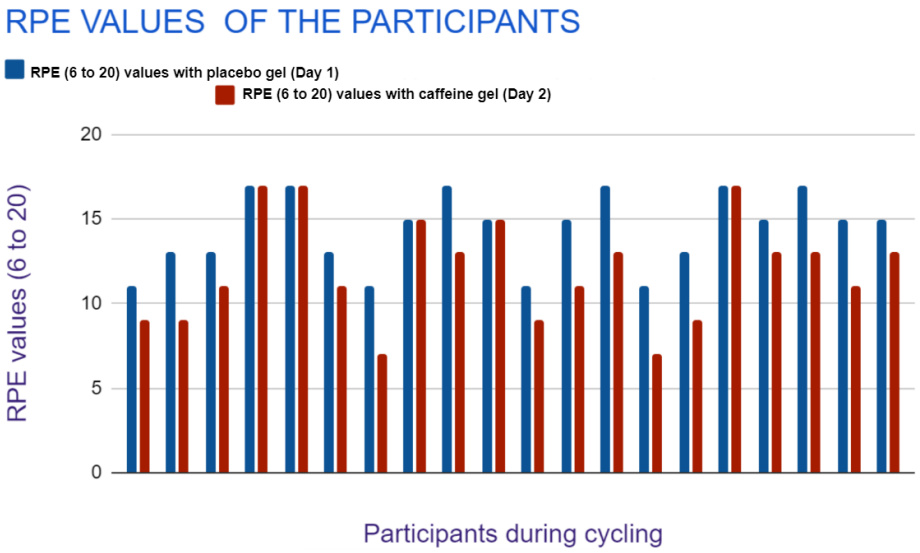


Figure 3: RPE values in cycling with placebo gel (blue) and caffeine gel (red)

Table 4: Descriptive analysis of average speed (kmph) of placebo and caffeine gel between group (N=20)

Parameter	**Group (Mean± SD)**	
	Cycling (N=20)	**Treadmill (N=20)**
Average speed with placebo gel (kmph)	**27.67 ± 2.29**	**8.13 ± 0.86**
Average speed with caffeine gel (kmph)	**28.85 ± 3.1**	**8.32 ± 0.9**

Among the study population, in cycling group the mean Average speed with placebo gel (kmph) was 27.67 ± 2.29 and it was 8.13 ± 0.86 in treadmill group (Table 4). And in cycling group the mean Average speed with caffeine gel (kmph) was 28.85 ± 3.1 and it was 8.32 ± 0.9 in treadmill group (Figure 4).

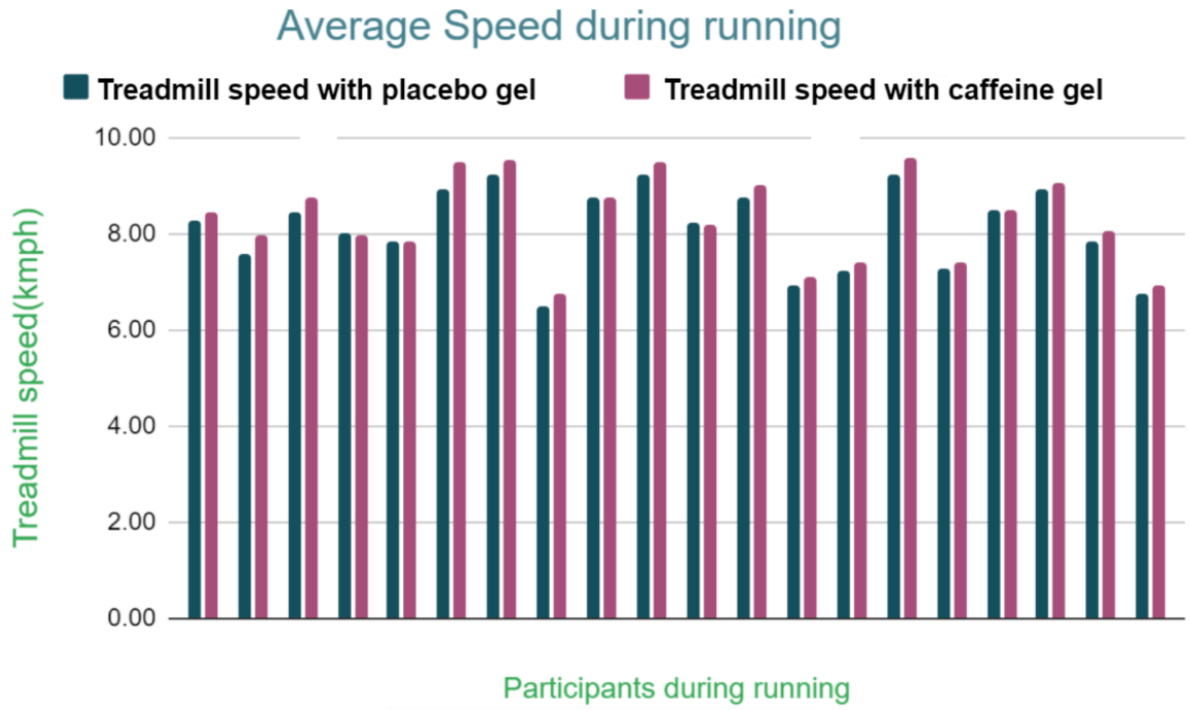


Figure 4: Average speed in treadmill with placebo gel (blue) and caffeine gel (pink)

Table 5: Comparison of mean of parameter during cycling (N=20)

Parameter	**Mean ± STD**	**Mean Difference**	**P-value**
Cycling timing with Placebo gel (10kms) Day 1 (mins)	21.83 ± 1.8	0.8	<0.001
Cycling timing with caffeine gel (10kms) Day 2 (mins)	21.03 ± 2.26		
Parameter	**Mean ± STD**	**Mean Difference**	**P-value**
RPE values with placebo gel Day 1 (6 to 20)	14.4 ± 2.26	2.4	<0.001
RPE values with caffeine gel Day 2 (6 to 20)	12 ± 3.15		

Parameter	Mean ± STD	Mean Difference	P-value
Average speed with placebo gel (kmph)	27.67 ± 2.29	-1.18	<0.001
Average speed with caffeine gel (kmph)	28.85 ± 3.1		

A statistically significant result was obtained with a p value <0.001, based on parameters such as time trial, RPE values, and average speed, comparing the mean cycling distance (10 km) with placebo and caffeine gel (Table 5).

Table 6: Comparison of mean of parameter during treadmill (N=20)

Parameter	Mean ± STD	Mean Difference	P-value
Treadmill timing with placebo gel (5 kms) Day 1 (mins)	37.34 ± 4.19	0.853	<0.001
Treadmill timing with caffeine gel (5kms) Day 2 (mins)	36.48 ± 4.07		
Parameter	**Mean ± STD**	**Mean Difference**	**P-value**
RPE values with placebo gel Day 1(6 to 20)	15.4 ± 1.39	2.400	<0.001
RPE values with caffeine gel Day 2 (6 to 20)	13 ± 2.43		
Parameter	**Mean ± STD**	**Mean Difference**	**P-value**
Average speed with placebo gel (kmph)	8.13 ± 0.86	-0.191	<0.001
Average speed with caffeine gel (kmph)	8.32 ± 0.9		

A comparison of the mean running distance (5 km) with placebo and caffeine gel produced a statistically significant result with a p value <0.001, based on parameters such as time trial, RPE values, and average speed (Table 6).

4. Discussion

In our study, all the subjects are elite cyclists who are doping prone and more focussed on performance enhancing substances. This was supported by V. Lentillon-Kaestner et al., whose study revealed that younger cyclists were not concerned about the long-term health consequences of banned substances, they were more focused on the short-term performance-enhancing benefits. There is a need to implement more effective preventive programs to change athletes' attitudes toward doping and its health risks(23).

In our study for a reliable measure of general doping attitude, we used the Performance-Enhancement Attitude Scale (PEAS). PEAS is a self-reporting questionnaire instrument, measuring the consciously thought and deliberately expressed (explicit) attitude toward doping. In its original version, Petróczi (2002) presented 17 statements about doping and substance use, which are judged unidimensional on a 6-point Likert-type scale. The resulting total score ranges from 17 to 102, with a theoretical middle-point of 59.5 (or 3.5 on the 6-point scale). Generally, the scale scores are interpreted as the higher the score, the more positive or lenient the attitude toward doping. We recruited elite cyclists based on the PEAS questionnaire. The reliability and validity of the PEAS questionnaire were corroborated by Dirk Folkerts et al., In their study of systemic analysis and meta-analysis found that the quantitative analyses yield an overall PEAS score of 39.18 (2.30 on a 6-point scale) and good internal consistency reliability (Cronbach's a = .81 [95%CI .80, .83])(24).

This research encompasses elite cyclists who use sports supplements on a regular basis and are constantly looking for performance-enhancing agents. The use of sports supplements has been in a considerably increasing trend. This was supported by Jesus Garcia Duran et al., in their study results showed that 62.5% of the sample cyclists used Sports Supplements, with an average of 12.2 ± 8.6 supplements consumed per participant(25). The literature on doping in sports includes studies on its prevalence; measurement methods; incidence among youth, enthusiasts, and professionals; its presence in specific sports, and the types of substances or supplements consumed(26). Ergogenic aids, also known as performance enhancers, are used in sports to boost athletes' performance. Sports performance enhancement teaches people to regulate their thoughts, minimize negativity and replace it with an optimistic thought process, and improve their attention and concentration, all of which are required for better athletic performance. Athletes in a variety of sports have tried to enhance their performance. Athletes who engage in prolonged, intense physical activity typically report that their primary reason for using SS is to improve performance, although improving/maintaining health may also be an important reason(27).

Many elite athletes take supplements in the hopes of improving performance. Caffeine (1,3,7-trimethylxanthine) is among the most popular ergogenic supplements. Caffeine supplementation has been shown to significantly improve multiple aspects of exercise performance. Many athletes believe it is one of the safest supplements available. Therefore, this study was conducted among 20 elite athletes to investigate the ergogenic effects of caffeine supplementation on a time trial basis and rating of perceived exertion. Caffeine is legal in sports governed by the World Anti-Doping Agency. It is currently on WADA's monitoring list, which means it is not prohibited but is being monitored in case it becomes an anti-doping issue in the future. In our study we used a standard dose of caffeine supplementation of 100 mg and this was supported by Nanci S Guest et al., In their review of the International Society of Sports Nutrition position stand: caffeine and exercise performance stated that Caffeine has consistently been shown to improve exercise performance when consumed in doses of 3-6 mg/kg body mass. Minimal effective doses of caffeine currently remain unclear but they may be as low as 2 mg/kg body mass. Very high doses of caffeine (e.g. 9 mg/kg) are associated with a high incidence of side-effects and do not seem to be required to elicit an ergogenic effect(28). And safety of caffeine was further supported by Jennifer L Temple et al., in their review reported that for healthy adults, caffeine consumption is relatively safe, but that for some vulnerable populations, caffeine consumption could be harmful, including impairments in cardiovascular function, sleep, and substance use(29).

Instead of dividing our participants into two groups, we performed this investigation. One day, a placebo gel was given to the same group, and the next day, a caffeine gel was given. While earlier studies emphasized the control arm, in our study, the same group received both supplements on different days to see a maximum number of participants with a particularly

positive attitude towards doping. In our study, we found that elite cyclists' time trial performance with placebo gel and caffeine gel during cycling 10 km was (21.83 ± 1.8 vs 21.03 ± 2.26 min: p <0.001). There was a better time trial performance after ingestion of caffeine gel. This was corroborated by Daniel Trujillo Colmena et al., In their study in comparison to the placebo, caffeine intake in the form of coffee significantly reduced the time to complete the trial by 4.93 ± 4.39% (43.20 ± 7.35 vs. 41.17 ± 6.18 min; p = 0.011; effect size [ES] = 0.300)(30). The time trial performance with placebo gel and caffeine gel in a treadmill 5km was (37.34 ± 4.19 vs 36.48 ± 4.07 min: p < 0.001). Caffeine supplementation resulted in improved time trial performance. This was supported by Matthew P O'Rourke et al., in their study Caffeine ingestion significantly improved 5-km running performance in both the well-trained and recreational runners. In comparison to the placebo trial, the caffeine trial resulted in 1.1% (90% CI 0.4-1.6) and 1.0% (0.2-2%) faster times for the well-trained and recreational runners. And their study concluded that caffeine ingestion is likely to produce small but significant gains in 5-km running performance for both well-trained and recreational runners(31).

In our study, the Rating of perceived exertion (RPE) values with placebo and caffeine gel during cycling 10 km was (14.4 ± 2.26 vs 12 ± 3.15: P < 0.001). RPE scales were lower after caffeine supplementation. This was supported by LG Killen et al., In their study about cycling after ingestion of caffeine resulted in significantly lower session RPE (p < 0.05) for caffeine (6.1 ± 2.2) versus placebo (6.8 ± 2.1)(32). In our study, the rating of perceived exertion (RPE) values with placebo gel and caffeine gel during treadmill 5 Km was (15.4 ± 1.39 vs 13 ± 2.43 : P < 0.001). RPE scale was lower after the caffeine supplementation. This was supported by systemic review by Juan mielgo Ayuso et al., In their study resulted better ergogenic effects of caffeine on jump performance, 4 (100%) on repeated sprint ability and 2 (100%) on running distance during a simulated soccer game(33).

A current study revealed that improved average speed during a cycling trial of 10 km. The average speed with placebo gel and caffeine gel after cycling was (27.67 ± 2.29 vs 28.85 ± 3.1 kmph P < 0.001). Similarly, the average speed during running was seen in treadmill of 5 km where the average speed was (8.13 ± 0.86 vs 8.32 ± 0.9 kmph p < 0.001). In treadmill very minimal improvement in speed after caffeine was observed. The speed improvement was supported by Jonathan D wiles et al., in their study about cycling speed after caffeine ingestion revealed that Mean speed was higher in the caffeine than in placebo and control conditions (caffeine vs. placebo vs. control: 50.7 +/- 1.4 vs. 49.1 +/- 1.5 vs. 49.2 +/- 1.7 km x h-1; P = 0.0005)(34).

This study observed that elite cyclists who already use supplements are more likely to use further performance-enhancing substances and have a constant desire for new ones. This will eventually lead to doping practices, as cyclists are constantly looking for alternative substances to improve performance and are more likely to face health consequences. Even if the organization of doping has today become more individualized, doping use is not an individual choice; it is influenced by the cycling environment and team staff. Managers of the current professional teams officially claim that they are against the use of banned substances, but certain comments led the cyclists who had recently become professionals to sometimes doubt their sincerity(35). The use of supplements can serve as a "gateway to doping", with doping rates being 3.5 times higher in the group using dietary supplements compared to those who do not use supplements(36). Elite cyclists may utilize caffeine as a safe supplement in moderate doses during cycling events. This study addressed the improvements in perceived exertion ratings and time trials following caffeine supplementation.

It is important to acknowledge the limitations of our study, even though it includes a substantial number of elite cyclists and offers novel findings. The use of self-reported questionnaires, which may generate errors, is one significant limitation. In our study placebo gel and caffeine

gel were administered to participants on alternative days. However, to reduce potential bias, a larger sample size randomised control trial with two equal groups could have been carried out.

Furthermore, this study excluded any potential long-term effects of supplement use on athletes' health by only taking into account caffeine supplements taken during the particular session in which the data were collected. These limitations emphasize the importance of providing careful consideration to the study's conclusion. Future directions should consider the long-term benefits of the caffeine supplement and add to that in multiple scenarios.

5. Conclusions

Elite cyclists consume a significant number of performance-enhancing agents. And most vulnerable to potential health risks and increased chances of doping. Elite cyclists with performance enhancement attitude might consider to prefer safer supplements like caffeine rather than using harmful supplements for a better sports performance. This study clearly addresses caffeine as a safe supplement in moderate doses that serves as a significant alternative and preventive measure against doping. It is important to prioritize awareness and educational initiatives among professional cyclists. Since doping prevention is important for athletes, evidence-based strategies based on supplement safety and results should be regularly considered by cyclists to keep them informed about the supplement and the significance of keeping them away from doping activities.

Acknowledgments
The present study was conducted entirely based on personal funds. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest
The authors declare that there is no conflict of interest.

6. References

1. de Hon O, Kuipers H, van Bottenburg M. Prevalence of Doping Use in Elite Sports: A Review of Numbers and Methods. Vol. 45, Sports Medicine. Springer International Publishing; 2015. p. 57–69.
2. Zmuda Palka M, Bigosińska M, Siwek M, Angelova-Igova B, Mucha DK. Doping in Sport—Attitudes of Physical Trainers Students Regarding the Use of Prohibited Substances Increasing Performance. Int J Environ Res Public Health. 2023 Mar 1;20(5).
3. Mauger AR, Thomas T, Smith SA, Fennell CRJ. Tramadol is a performance-enhancing drug in highly trained cyclists: a randomized controlled trial. J Appl Physiol. 2023 Aug 1;135(2):467–74.
4. Pickering C, Grgic J. Caffeine and Exercise: What Next? Vol. 49, Sports Medicine. Springer International Publishing; 2019. p. 1007–30.
5. Guest NS, VanDusseldorp TA, Nelson MT, Grgic J, Schoenfeld BJ, Jenkins NDM, et al. International society of sports nutrition position stand: caffeine and exercise performance. Vol. 18, Journal of the International Society of Sports Nutrition. BioMed Central Ltd; 2021.

6. Krishnan A, Datta K, Sharma D, Das Sharma S, Mahajan U, Jhajharia S, et al. Survey of antidoping knowledge, attitudes and practices amongst elite Indian sportsmen and the way forward. Med J Armed Forces India. 2022 Jan 1;78(1):88–93.
7. Chan DKC, Tang TCW, Yung PSH, Gucciardi DF, Hagger MS. Is unintentional doping real, or just an excuse? Br J Sports Med. 2019 Aug 1;53(15):978–9.
8. Gatterer K, Gumpenberger M, Overbye M, Streicher B, Schobersberger W, Blank C. An evaluation of prevention initiatives by 53 national anti-doping organizations: Achievements and limitations. J Sport Health Sci. 2020 May 1;9(3):228–39.
9. Phillips KE, Hopkins WG. Factors affecting cyclists' chances of success in match-sprint tournaments. Int J Sports Physiol Perform. 2019;14(4):472–7.
10. Clarke ND, Kirwan NA, Richardson DL. Coffee ingestion improves 5 km cycling performance in men and women by a similar magnitude. Nutrients. 2019;11(11).
11. Glaister M, Moir G. Effects of Caffeine on Time Trial Performance and Associated Physiological Responses: A Meta-Analysis. J Caffeine Adenosine Res. 2019 Jun;9(2):40–52.
12. Arney BE, Glover R, Fusco A, Cortis C, de Koning JJ, Erp T van, et al. Comparison of RPE (rating of perceived exertion) scales for session RPE. Int J Sports Physiol Perform. 2019;14(7):994–6.
13. Guest NS, VanDusseldorp TA, Nelson MT, Grgic J, Schoenfeld BJ, Jenkins NDM, et al. International society of sports nutrition position stand: caffeine and exercise performance. Vol. 18, Journal of the International Society of Sports Nutrition. BioMed Central Ltd; 2021.
14. Duncan MJ, Stanley M, Parkhouse N, Cook K, Smith M. Acute caffeine ingestion enhances strength performance and reduces perceived exertion and muscle pain perception during resistance exercise. Eur J Sport Sci. 2013 Jul;13(4):392–9.
15. Grgic J. Exploring the minimum ergogenic dose of caffeine on resistance exercise performance: A meta-analytic approach. Vol. 97, Nutrition. Elsevier Inc.; 2022.
16. Wikoff D, Welsh BT, Henderson R, Brorby GP, Britt J, Myers E, et al. Systematic review of the potential adverse effects of caffeine consumption in healthy adults, pregnant women, adolescents, and children. Food and Chemical Toxicology. 2017 Nov 1;109:585–648.
17. Francke A. Cycling during and after the COVID-19 pandemic. In: Advances in Transport Policy and Planning. Elsevier B.V.; 2022. p. 265–90.
18. Muthiah A, Lee YC. Comparative Analysis of Male Cyclist Population in Four Asia Countries for Anthropometric Measurements. Int J Environ Res Public Health. 2022 Aug 1;19(16).
19. Van D, Daniel R, Larson J. The Economics of Professional Road Cycling [Internet]. Available from: http://www.springer.com/series/8343
20. Kumar M. A STUDY OF INCREASING DOPING IN ALL INDIA INTER-UNIVERSITY SPORTS COMPETITIONS [Internet]. Vol. 11, International Journal of Creative Research Thoughts. 2023. Available from: www.ijcrt.org
21. Boardley ID, Chandler M, Backhouse SH, Petróczi A. Co-creating a social science research agenda for clean sport: An international Delphi study. International Journal of Drug Policy. 2021 Jun 1;92.
22. Pöppel K. Efficient Ways to Combat Doping in a Sports Education Context!? A Systematic Review on Doping Prevention Measures Focusing on Young Age Groups. Vol. 3, Frontiers in Sports and Active Living. Frontiers Media S.A.; 2021.
23. Lentillon-Kaestner V, Hagger MS, Hardcastle S. Health and doping in elite-level cycling. Scand J Med Sci Sports. 2012 Oct;22(5):596–606.

24. Folkerts D, Loh R, Petróczi A, Brueckner S. The performance enhancement attitude scale (PEAS) reached 'adulthood': Lessons and recommendations from a systematic review and meta-analysis. Vol. 56, Psychology of Sport and Exercise. Elsevier Ltd; 2021.
25. García-Durán J, González-Jurado JA, Sánchez-Oliver AJ. Analysis of Sports Supplement Consumption in 1688 Federated Road Cyclists. Nutrients. 2024 Jan 1;16(1).
26. Aubel O, Ohl F. An alternative approach to the prevention of doping in cycling. International Journal of Drug Policy. 2014;25(6):1094–102.
27. Jiménez-Alfageme R, Rubio-Quintanilla N, Romero-García D, Sanchez-Oliver AJ, Sospedra I, Martínez-Sanz JM. Are the Consumption Patterns of Sports Supplements Similar among Spanish Mountain Runners? Nutrients. 2023 Jan 1;15(2).
28. Guest NS, VanDusseldorp TA, Nelson MT, Grgic J, Schoenfeld BJ, Jenkins NDM, et al. International society of sports nutrition position stand: caffeine and exercise performance. Vol. 18, Journal of the International Society of Sports Nutrition. BioMed Central Ltd; 2021.
29. Temple JL, Bernard C, Lipshultz SE, Czachor JD, Westphal JA, Mestre MA. The Safety of Ingested Caffeine: A Comprehensive Review. Vol. 8, Frontiers in Psychiatry. Frontiers Media S.A.; 2017.
30. Trujillo-Colmena D, Fernández-Sánchez J, Rodríguez-Castaño A, Casado A, Del Coso J. Effects of Caffeinated Coffee on Cross-Country Cycling Performance in Recreational Cyclists. Nutrients [Internet]. 2024 Feb 27;16(5):668. Available from: https://www.mdpi.com/2072-6643/16/5/668
31. O'Rourke MP, O'Brien BJ, Knez WL, Paton CD. Caffeine has a small effect on 5-km running performance of well-trained and recreational runners. J Sci Med Sport. 2008 Apr;11(2):231–3.
32. Killen LG, Green JM, O'Neal EK, McIntosh JR, Hornsby J, Coates TE. Effects of caffeine on session ratings of perceived exertion. Eur J Appl Physiol. 2013 Mar 1;113(3):721–7.
33. Mielgo-Ayuso J, Calleja-Gonzalez J, Del Coso J, Urdampilleta A, León-Guereño P, Fernández-Lázaro D. Caffeine supplementation and physical performance, muscle damage and perception of fatigue in soccer players: A systematic review. Nutrients. 2019 Feb 1;11(2).
34. Wiles JD, Coleman D, Tegerdine M, Swaine IL. The effects of caffeine ingestion on performance time, speed and power during a laboratory-based 1 km cycling time-trial. J Sports Sci. 2006 Nov;24(11):1165–71.
35. Lentillon-Kaestner V. The development of doping use in high-level cycling: From team-organized doping to advances in the fight against doping. Scand J Med Sci Sports. 2013 Apr;23(2):189–97.
36. Scott JM, Ortiz AS, Ma SA, Deuster PA. Dietary Supplements: knowledge and Adverse Event Reporting among Emergency Medicine Physicians [Internet]. 2018. Available from: www.scireslit.com